A NEW METHOD

OF TRACKING VESSELS.

Fig. 1st

ds eye view of a Canal or River, fitted up as proposed, with Ropes, Buoys, and with Locomotive Engine Boat, ready to proceed from first station A.

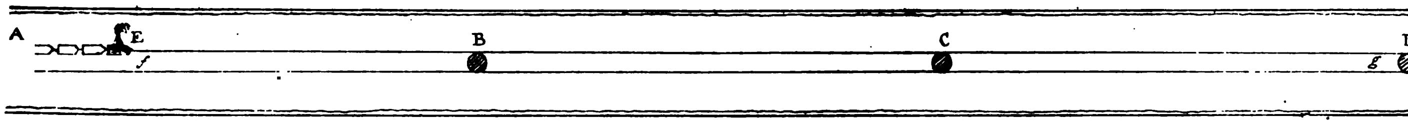


Fig. 2nd

Birds eye view of the same after arrival of Locomotive Engine Boat at second station B.

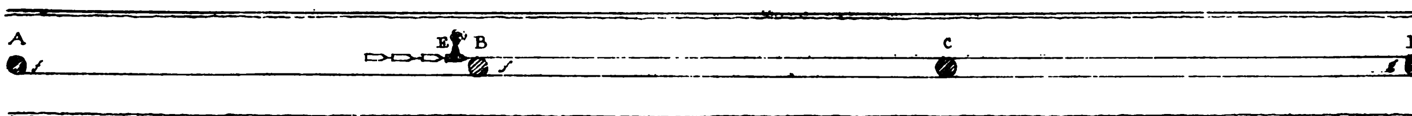
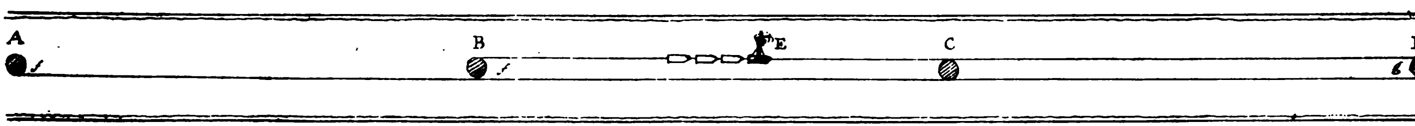


Fig. 3rd

Birds eye view of the same with Locomotive Engine Boat between second station B, and third station C



Explanation

A.B.C.D. Stations mentioned in letter.

E. Locomotive Engine Boat, with attached Vessels.

f.g. Ropes stretched from station to station.

In the above Sketch, the Canal or River is for the sake of distinctness fitted up with buoys, and not with pillars.

J. Watson Lith.

GLASGOW:
ANDREW & JOHN M. DUNCAN,
Printers to the University.

A
LETTER,
ADDRESSED TO THE
PROPRIETORS AND MANAGERS
OF
CANALS AND NAVIGABLE RIVERS,
ON A
NEW METHOD
FOR
TRACKING AND DRAWING VESSELS
BY A
LOCOMOTIVE ENGINE BOAT,

WITH MUCH GREATER SPEED, AND AT LESS THAN ONE THIRD OF THE PRESENT EXPENSE.

BY THOMAS GRAHAME, ESQ.
GLASGOW.

LONDON:
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Printers to the University.

of locomotive and fixed steam engines, that they are now held out not only as formidable rivals to canals, but as about to supersede canal navigation altogether.

Your indifference on this subject can only be accounted for by the general impression that the mode of conveyance along your navigations was already perfect, and that no improvement could be made on it. And when it is considered that a single horse exerting his strength in a way most unfavourable to its effect, can, on a moderate sized canal or navigation, draw from thirty to forty-five tons, whilst, on the best constructed level railway, and whilst exerting his strength in the way most favourable to its effect, a horse cannot draw one-fourth part of the above weight; we are apt to suppose the farther improvements of canal or navigation carriage as unnecessary.

It has however often occurred to me, and it must have also occurred to others, that the application of the power of the steam engine, as the moving power on canals, was an object greatly to be desired, although many difficulties seemed to be opposed to it. Every one is aware of the application of the steam engine to the navigation of vessels at sea, and on lakes and rivers, by the action of wheels and paddles on the water; but it is also

known that a very great proportion of the power thus applied is absolutely wasted and lost from the fluidity and nature of the medium on which the paddles have to act. This great waste of force prevents the general extension of steam power to trackage on rivers as too expensive; and it is evident that if wheels or paddles were to be applied to the water of canals for propelling vessels, a great part of the power would be not merely lost, but would be most effectually applied to the destruction of the banks of the canals by the violent agitation of the water. An experiment for dragging vessels along the Forth and Clyde canal by a steam-boat was made in the year 1802, but on trial it was found not to answer.

The first suggestion made to the public* since the year 1802, for the improvement of canal navigation, by means of the steam engine, proceeded from an advocate and promoter of railways. It appeared, and will be found in an anonymous pamphlet, entitled "Observations on a general Iron Railway," published about two years ago, by Messrs. Baldwin, Cradock, and Joy. In this pamphlet it is proposed to employ the locomotive engine, or, as it may be more properly called, the

* It had, I believe, been previously suggested, though not published, by a gentleman with whom I am well acquainted.

locomotive engine waggon, to run along the banks of canals, and to draw after it the canal boats and vessels.

Locomotive engine waggons thus employed along the banks of canals, would have this great advantage over those employed in drawing carriages along railways, that, whereas, at almost every ascent of the railways, however moderate, the locomotive engine waggon not only loses all its power of drawing other carriages, but would itself require to be drawn up the ascent; whilst on canals, where an ascent occurs, the boats and vessels are raised over the ascent by means of locks, and the engine has only to raise itself, which it may easily accomplish by a rope or chain fixed at the top of the locks, and then be ready to proceed with its load, viz. drawing the vessels along the upper level of the canals.

On the disadvantage attending the locomotive engine waggon in getting over the ascents of railways, Mr. Wood, the patron and promoter of these engines, states the following as facts: "That a quarter of an inch rise in a yard, or 1 in 144, is the greatest rise on which it would be expedient to use locomotive engines. That a locomotive engine exerting a pull equal to 972 pounds, and capable of drawing twenty waggons of coals on a level railroad, is only capable of drawing twelve waggons

up the same railroad, when the ascent is one eighth of an inch in a yard, or 1 in 288." Mr. Sylvester, an engineer, lately employed to report on locomotive engine waggons by the Liverpool and Manchester railroad company, states in his report, "That an inclination of one-ninth of an inch in a yard, or 1 in 324, is as great, and perhaps a greater inclination than any railroad ought to have, where loaded carriages go up and down." To none of these disadvantages would locomotive engine waggons tracking on canals be subjected.

The objections to running locomotive engine waggons on the banks of canals, for tracking boats and vessels along the canal, are, however, many and obvious. Independent of the danger attendant on the use of these engines, which must be all of the high pressure kind, the expense of making the road along the banks for this purpose, and the tear and wear of these roads would be very great, and the application of the power to dragging on the canal being necessarily by a lateral pull, would be a great disadvantage. But independent of these circumstances, it is a matter still in doubt and unsettled, whether any saving has ever been effected by the substitution of the locomotive engine waggon, in room or place of horse labour. The advocates and opponents of locomotive engine waggons differ so materially in

their calculation of the expenses attending their use and employment on railroads, that a general doubt and uncertainty as to the benefits to be derived from this application of the power of steam, still prevails among all unbiassed and impartial engineers and mechanics.

To show the very different views taken by scientific practical men, of the powers and use of these locomotive engine waggons, and of the expenses attending their employment, I need only refer you to the public correspondence on the subject (which appeared in the Newcastle Magazine for the year 1822) between Mr. Wood of Killingworth, already mentioned, a great patron and promoter of locomotive engines, and Mr. Thomson of Ayton Banks, the patentee of fixed, or as he calls them, reciprocating engines.

It is held by experienced engineers that a locomotive engine waggon, when employed on a railway, cannot apply to dragging carriages more than a third part of its nominal power. If, however, the powers and properties of locomotive engine waggons be at all equal to what they have been stated to be by their patrons, it appears from all the calculations and enquiries I have made, that by applying them to move on the banks, and to draw ves-

sels along Canals, a very considerable saving of time and of expense would be effected.

The controversy between Mr. Wood and Mr. Thomson abovementioned, in which Mr. Thomson sets forth the disadvantages of locomotive engine waggons, and the advantage of fixed, and as Mr. Thomson calls them, reciprocating engines for drawing carriages along railways, led me to consider whether these fixed engines might not be better adapted than locomotive engine waggons to the purpose of drawing vessels along canals.

It appears from Mr. Thomson's statements, that a fixed Engine can draw along a rail-road, by means of a rope, a large number of waggons at a rate or speed of seven miles an hour (about double the speed which I believe has hitherto been attained by the locomotive engine waggon) and that the fixed engine will operate at a distance of upwards of three miles, even although the rail-road be curved or undulating, and that these fixed engines realizè much more than double the power which a locomotive engine waggon, acting by the friction of its soft wheels on a rail-road, can ever realize.

Were such fixed engines established on the banks of

canals for dragging vessels, a much greater proportion of the power of the steam would be applicable to the draught, and the great expense of making and repairing roads for the locomotive engine waggon would be saved.

But however preferable the use of fixed engines for trackage on canals may be to the use of locomotive engine waggons, still there are many and great disadvantages attending the use of these fixed engines. The great distance between the acting power of the fixed engine and the boats or vessels which it would be employed to draw, make it necessary to keep up a communication by signals between the fixed engine and the boats. The outlay consequent on the great number of engines (one at the end of each two, three, or four miles) which it would be necessary to erect, is a serious objection; and the necessity of keeping them constantly prepared to work on the canals would be an additional expense.

After long consideration of the subject, a plan has occurred to me which appears to unite the advantages of locomotive as well as of fixed engines, and to be free from the disadvantages attending the use of either the one or

the other, and to this improvement I am now about to call your attention.

By Mr. Thomson's plan, the steam engine is built or fixed and immoveable at a particular station, where it acts on a rope wheel, drum, or cylinder, also fixed to the station and coils round it a long rope. This rope is stretched along the railway, and the farther end of it is attached to the waggons, which are thus drawn by the power of the engine from a distance sometimes of two or three miles. The engine thus acts by means of the rope for the length of several miles. Where at any place there occur turns or curves in the railway, the rope is kept in the proper line by means of posts furnished with wheels along which the rope runs.

I would propose to reverse this plan for canals and rivers; and, instead of a fixed steam engine, I would place the engine in a boat, whereby it would obtain a locomotive power. The boat would require to be fitted up with two rope-wheels, drums, or cylinders, on which the engine might act alternately. To distinguish this boat in future, I will call it by the name of the *Locomotive Engine Boat*. To enable the engine to act, there should be erected or built on the bank of the canal or river, strong pillars with iron work and

hooks, at each place where a stationary engine would, according to Mr. Thomson's plan, be necessary. From one to another of these pillars, two lines of rope or fine strong chain, would require to be stretched. Each rope would terminate on a pillar, and have at each end the necessary hooks for attaching it to these pillars, or to the cylinder or drum erected in the Locomotive Engine Boat. The number of pillars on a canal need only be limited by the length of rope which the engine could with ease coil on the cylinder or drum.

To make the case more clear, I shall suppose a canal fitted up in the manner proposed, with four strong pillars erected at the points A, B, C and D. To each of these pillars are attached two ropes by hooks. The first set of ropes stretches from the point A to the point B, the second from the point B to the point C, and so on. The locomotive engine boat being about to start from the point A, one of the ropes is detached from the pillar A, and attached to one of the rope-wheels, drums, or cylinders erected in the engine boat. The steam engine, being put in motion, causes the cylinder to revolve and to coil up the rope, and in this way drags itself with the attached boats or rafts to the point B. At this point the first cylinder or drum is thrown out of gearing, and the power of the steam engine is brought

to operate on the second cylinder or drum, to which is attached one of the ropes extending from the point B to the point C, In this way the locomotive engine boat again drags itself forward from the point B to the point C. The first cylinder being in the mean-time thrown out of gearing, the rope which had previously been coiled up on it being still attached to the pillar B, is, as the locomotive engine boat advances to the point C, uncoiled from the first drum or cylinder, and then stretches from the point B to the point C, to which it is attached, and thus replaces the rope which has been taken up on the other or second drum: this operation of uncoiling may be aided, if necessary, by the steam engine.—In this way the locomotive engine boat, with its attached boats, moves on to the end of the canal at the point D. By the return of this or any other locomotive engine boat from the one end of the canal at the point D, to the other at the point A, the ropes are replaced in their original position. Where turns or bends occur in the canal, the rope is kept in its place in the line of the canal by means of posts, in the way done on rail-roads, where Mr. Thomson's fixed engines are employed.

The whole process is extremely simple, and will easily be understood by any person in the least degree ac-

quainted with the modes in which fixed engines are made to drag waggons along rail-roads, and which is described by Mr. Thomson in the specification and observations in his patent, inserted in the second series of the Repertory of Arts and Manufactures, No. 238, March 1822. By Mr. Thomson's plan the power of the steam engine acts through the medium of a rope on a moveable point, the engine itself being immoveable. According to my proposal the power of the steam engine acts through the same medium on a fixed point, the engine itself being moveable.

In regard to the mode of attaching the boats to each other, and to the locomotive engine boat I would propose, in order to prevent the running of one boat against the other, that they should be connected by short iron or timber rods, with blunt or broad ends, to which two or three links of a chain might be attached, by which each boat would be connected with the one preceding it. The links of the chain would enable the line of boats to make such a bend as would be necessary at curves; the iron rod would prevent them running foul of each other, on the occasion of any stop, and the blunted end of the rod would prevent any damage from concussion. To prevent injury to the rope by sudden jerks or pulls stronger than the regular pull, the

first boat of the fleet should be attached to the locomotive engine boat by a strong elastic spring. When two locomotive engine boats and their fleets met, in order to enable them to pass, it would only be necessary for one of them to throw the working wheel out of gearing; it would then advance by its own velocity, while the rope in front would sink to the bottom of the canal or river, so that the other boat and fleet would pass over. The same purpose would be accomplished on the rope let out behind, by throwing it more rapidly off the unemployed wheel-rope or drum.

I have no doubt whatever that various and great improvements will be made on the above proposal, and there are a great number of improvements which I myself could suggest, particularly on the mode of coiling and uncoiling the rope, to save delay at the different fixed pillars. But I wish to confine myself as far as possible in my proposed plan, to processes which have undergone the test of experiment. I shall therefore proceed to consider the adaptation of my plan to the different kinds of canals, and to rivers, firths, and the entrances of harbours.

The first kind of canals that will fall to be considered are those of the largest class, which are capable of

receiving masted sea vessels, and which are crossed where necessary by means of draw-bridges. At each of these draw-bridges some delay occurs, and it will be obvious, that as a delay must occur there at any rate, this will be the proper place for having a pillar. If this situation be not convenient, the rope can easily be made to pass under the bridge to the next station. If it is convenient to change the rope at the draw-bridge, it might be an improvement to fasten it, not to a pillar at the side, but to a strong beam, which would cross the canal at the same place with the draw-bridge. When on its approach to the bridge the locomotive steam boat slackened its speed by throwing the operative wheel or drum out of gearing, this post might be raised, and the whole boats pass through the bridge. By the above plan it is obvious, that from the length of the warping or towing rope a great part of the lateral pull, so prejudicial to the exercise of horse power on canals, would be avoided. At bridges where the rope would be fastened in the centre of the canal, there would be no lateral pull at all.

Hitherto the amount of the loss of power on canal trackage, in consequence of the lateral pull, has not been ascertained. It has been variously estimated by scientific men, and these estimates differ very considerably in amount. That it is large, must be evident to every one

who has seen boats tracked upon a canal. They must have observed the very great length of rope used for the purpose of towing. Every part of this rope, except the small portion necessary to attach the harness of the horse to the boat tracked, acts as a deduction from the amount of power or strength which the horse can apply to the trackage of the boat. The strength of the horse is wasted in drawing a rope, when it ought to be employed in tracking the boat. This length of rope however cannot be got quit of without a much more serious deduction from the power of the horse, in consequence of the increase of the lateral pull, which a short rope would occasion. In Holland, where canals are much more common than in this country, and where canal boats are much more frequently used for the purpose of travelling, very fine spun, thin, strong ropes are used; by which means the length of the track-line can be much increased, and the lateral pull diminished, without any great corresponding increase of burden on the horse.

It has occurred to me, that, in order to get quit of the lateral pull altogether, it would be desirable to devise a mean of attaching the tracking ropes to be used under my present proposal, in the centre of the canal. This can be easily done in small canals, but will be attended

with certain difficulties in canals such as we are now treating of, and also in navigable rivers. In the canals now under consideration, it might be done by a strong beam stretched across the canal, to the centre of which the ropes would be hooked; this beam might either be raised up on the approach of a boat, or it might be made to swim on the surface of the canal, and be attached to the sides by chains, and it could be then loosed and pulled aside on the approach of a boat. In this way, however, a keeper, with his house and other establishments, would be necessary at each station. To avoid this expense, I would propose, that a strong heavy stone should be sunk and fastened in the bottom of the canal, to which should be attached, by a chain or rope, a floating buoy, with the necessary iron work, for attaching the tracking ropes. In this way no pillars would be necessary, and no danger or obstruction to the navigation would ensue, as boats striking against the buoy or running over it, would sustain no damage whatever. It is obvious, that in this way the whole force or power presently wasted on canals, in order to overcome the lateral pull, would (except where curves occur,) be saved, and might be applied to its real object, viz. the moving of the boats. I cannot see any difficulty which may not be easily overcome, in the methods proposed, to get rid of the lateral pull.

I shall now proceed to consider the case of small canals, navigated merely by barges or boats, which pass under the stone arches or other fixed bridges thrown over these canals. In these canals, I think, fixed posts may at once be dispensed with, and the tracking ropes can easily be attached to the bridges themselves, which, if necessary, may be strengthened, to enable them to sustain the pull to which they would be subjected. Buoys might also be used in such canals, and if they were found not to succeed, a bridge might be built at places where pillars would otherwise be necessary.

It may be objected to the present proposal, that where locks occur on canals, whether these canals be large or small, a very great delay would ensue in passing through a fleet of six, eight, or ten boats, which would not occur in the case of one boat tracked through by a horse. Here a single boat would only suffer the delay consequent to the passage of one boat, while every boat in the fleet would suffer a delay of several times this amount, at each lock. To this objection, I would answer, that it is inapplicable to a long canal, in as much as the delay occasioned by the stoppage of the horses to feed and rest, will more than cover the delay at locks; and from what will be hereafter stated on the subject of short canals, (and which is equally applicable to long,)

it will be seen that no delay, but on the contrary, a great increase of speed will be obtained by the application of this mode of conveyance on long canals.

In short canals, where the whole passage can be performed by a horse, without any stoppage, the answer as to the delay in resting and feeding the horses is not sufficient. On these canals, if the locks occurred all at one place, the delay could not be great, because, as soon as the first boat had passed into the second lock, the second boat would pass into the first, and so on through the whole fleet. Where locks were so disposed of in a canal, the locomotive engine boat might either pass through these locks, or remain on one level, as appeared most convenient, and the work on the other level might be done by a second locomotive engine boat. Where locks occurred at distances, not very great, the locomotive engine boat having passed through the first locks, with a third or a half of its fleet of boats, might proceed to the next lock with a very much increased speed, from its surplus power, and leaving these boats to pass through the second lock, might return with a still increased speed to the first passed lock, and bring forward the remaining part of the fleet of boats. A great source of delay would also be saved in this, that the fleets of boats would always arrive

at the locks and bridges at a fixed time, and every keeper, &c. would be prepared to receive them. By these methods, a great part of the delay at passing locks would be saved. A much greater delay, however, would be saved by the constant and regular application of the pulling or dragging force to its intended purpose. This has not hitherto been accomplished on canals. From various causes, which it would be needless here to mention, the force exerted by a horse in pulling on a canal, is in a constant state of variation, insomuch that, although many attempts have been made, it is impossible to ascertain what is the exact strength he requires to exert in order to pull forward boats at different velocities. The force or power exerted is found never to be regular, but is constantly varying, and can only be estimated, most unsatisfactorily, by an average. The late Mr. Watt estimated, that a horse going at the rate of two miles and a half an hour, could raise a weight of 150 pounds by a rope passed over a pully. This power, or such part of it as may be required, he can exercise on a canal, and if the power was always equally exerted, it would be very easy to ascertain the exact amount necessary to be exerted, in order to drag forward different boats at different velocities. As already observed the horse's power is not equally exerted; and

putting all other causes out of the question, the force or power must always vary, until some method is found by which the horse will be confined to one line of the tracking path, always parallel to, or at the same distance from the edge of the canal. Every deviation from this direct line will be attended with a variation in the force necessary to drag forward the attached boat. It would be needless to enter into a disquisition on the advantages to be derived from a regular and constant pull or application of force, to vessels tracked on a canal; but I think I am rather under than above the mark, when I say that this regular pull being obtained, it will, (except in a very few cases,) much more than compensate for the delay consequent in the passage of locks by boats, which are conveyed along a canal in fleets.

I shall now proceed to consider the proposed plan as applicable to navigable rivers and the entrances of harbours.

Here the advantages of the plan are very great. The only mode hitherto practised of dragging vessels on navigable rivers, where there is a tide way, has been by steam-boats, where the force of the steam engine is exerted on the water, by means of paddles. Of all the

applications of the power of the steam engine, this is perhaps the most wasteful; except in the case of the locomotive engine waggon, I know of no other application of the steam engine, where, with an enormous exertion of power, so little is attained. This arises chiefly from the nature of the medium on which this power has to exert itself. It has never been ascertained what is the exact amount of power which a steam engine, placed in a boat, realizes for the purpose of being applied to the end in view, or for which it was placed in the boat, viz. the propelling of the boat in which it is placed, or of other boats which may be attached to it. The proportion, however, is very small, and of course the expense of trackage is very great; and the employment of steam power is thus proportionally narrowed. According to the proposed plan, the steam engine would be enabled to realize nearly the whole of its power. Mr. Thomson of Aytonbanks states, from experiment, that his fixed engines realize upwards of three fourths of their nominal power:—" That, on one of his railroads, a twenty-five horse engine works efficiently up to rather more than eighteen horses, *and has spare power.*" If such be the case, I think I may safely calculate, that, with its advantages over Mr. Thomson's system, (which will hereafter be brought to view) a locomotive engine boat will re-

alize at least an equal proportion of power; which power it can let out for the purpose of dragging vessels at a much lower rate than a common steam-boat ever can afford. The expensiveness of the application has hitherto prevented the general employment of steam-boats to the towing of vessels on the Thames, the Mersey, the Clyde, and other rivers, and has equally limited their application to the towing of vessels out of harbours. In the river Thames, the steam-boats, which, during the spring, summer, and harvest months of the year, are employed to carry passengers between London and Leith, being thrown idle from autumn to spring, are employed to tow vessels up and down the Thames. If these vessels were furnished with an apparatus similar to that proposed for the canal boats, they might perform an additional quantity of work, so great as would be difficult to estimate.

At Liverpool, where a number of vessels are in calm, or otherwise unfavourable weather detained in, or towed out of port at a very great charge, the proposed plan will be of great utility.—Both on rivers, and at the entrances of harbours, the towing apparatus should be attached to buoys. I need not dwell upon the advantages of my plan, as applicable to rivers, farther than to notice the particular importance of its applica-

tion to rivers where the current runs constantly in one direction, and which are impeded by rapids. In such rivers, in addition to all other disadvantages, steam-boats ascending or going contrary to the current of these rivers, realize still less of the power of the engine, the paddles being applied not to water, in a state of rest, but to water receding from the stroke of the paddles. In such rivers, supposing the plan proposed to be found on experiment not calculated to supersede the common steam-boat, yet it might be adopted at rapids. Here the rope might be attached to a fixed point at the top of the rapid, and might be allowed to float down the rapid with an attached buoy. When the steam-boat arrived where the buoy floated, it would only be necessary to take up the buoy, attach the rope to the necessary apparatus, and stopping the action of the engine on the paddles, cause it to act on the attached wheel-rope, drum, or cylinder, and thus proceed to the top of the rapid. The rope might be afterwards used to prevent the steam-boat, on its return, going at too great velocity down the rapid. This application of my plan would be particularly suitable to several of the American rivers, where steam navigation is already employed, and where the progress of the steam-boats, up the river, is either totally stopped, or greatly impeded by rapids.

It will be proper now to consider and compare the expenses of the different modes of conveyance beforementioned, and to see what saving of expense, and other advantages, are likely to be the result of the plan I have proposed.

I have already mentioned, that there are three modes by which waggons are at present drawn or propelled along railroads: first, by horses; second, by locomotive engine waggons; and third, by fixed reciprocating engines. Many of the first engineers in Great Britain, consider the application of the steam engine, to the conveyance of waggons along railroads, in any of the modes hitherto invented, as much more expensive than the trackage by horses. They instance the very great number of cases, where, after steam power has been applied to the conveyance of carriages along railroads, the parties so doing have been obliged again to resort to the use of horses. Taking for granted, however, the truth of all the allegations of the patrons of steam conveyance on railways, it must be evident that if this application produces a saving upon railroads, it must produce at least an equal saving in its application to canals. The following are the calculations of Mr. Wood of Killingworth, as to the expense incurred in the trackage of coals along a railroad by a horse, by

fixed engines according to Mr. Thomson's patent, and by locomotive engine waggons:

1st. Horses—$\frac{75}{100}$ of a penny per ton per mile.
2d. Locomotive engine waggons—$\frac{20}{100}$ of a penny per ton per mile.
3d. Fixed engines—$\frac{50}{100}$ of a penny per ton per mile.

Mr. Thomson of Ayton-banks asserts, on the contrary, that the following are the charges or expenses of trackage on railroads by the three methods above-mentioned:

1st. Horses—$\frac{51}{100}$ of a penny per ton per mile.
2d. Locomotive engine waggons—$\frac{44}{100}$ of a penny per ton per mile.
3d. Fixed engines—$\frac{22}{100}$ of a penny per ton per mile.

These gentlemen differ very materially in their calculations as to the power of a horse on a railway, and as to the expense of their respective plans, of locomotive engine waggons and fixed engines, and both support their assertions by *long calculations.* Whoever is in the right it does not affect my statement. If, by the exertion of a force of 150 pounds, or whatever other force a horse is capable of exerting, he can drag forward in a boat on a canal, a weight greater than four or five times he can drag forward in waggons on a railroad, the speed being the same, it must be quite clear that a

locomotive engine waggon or fixed engine exerting the same power on a canal which it does upon a railway, will produce the same proportional effects. Of course if steam power, in so far as hitherto applied, be preferable to horse power on a railway, it will be in the same ratio preferable on a canal. It only therefore remains for me to show, that my new proposed method is preferable to the locomotive waggon or fixed engine for tracking vessels along canals, and it follows as a consequence that it must be very far preferable to horses.

In comparing my plan of tracking by a locomotive engine boat, in place of a locomotive engine waggon, the first and most obvious advantage which my plan possesses, is that thereby the employment of the high pressure steam engine can at once be dispensed with. In stating this advantage, I do not consider the expense of these engines, but the great risk and waste of human life which they occasion. Putting this out of the question, and supposing the risk and danger attendant on their employment, in so far as regards the life of men, were most improperly considered as nothing, yet the high pressure engines could not be employed on a canal where there were aqueduct bridges, without a risk of the destruction of these aqueducts, a consequent escape of the whole water in the canal and the destruction of the surround-

ing country, to the ruin of the fortunes of the canal proprietors, who would be liable in all the losses consequent on such an accident. There have been more lives lost in America, through the use of these engines, than I believe have been lost in all the rest of the world by the use of the low pressure engine.

2d.—The whole expense of a railroad or other path, or road, along the banks of a canal will be saved, and the tracking path may be thrown in to increase the width of the canal, by which the boats will be enabled to proceed at a much more rapid rate.

3d.—The lateral pull will by my method be almost entirely got quit of, and a much greater power of the steam engine will be realized and made efficient for the purpose intended, viz. the tracking of vessels.—In short my plan can be put into execution, and afterwards carried on at a mere per centage of the charges for preparing and fitting the banks of the canal for the motion of the locomotive waggons and keeping them in repair.

I shall next consider my plan as compared with Mr. Thomson's plan of effecting motion and carriage, by

means of fixed engines. The advantages of my plan over Mr. Thomson's are,—

1st. That the steam engine employed in dragging, obtains by being placed in a boat, a locomotive power; and, that being thus enabled to exercise this power along the whole line of the canal, a great number of engines are dispensed with. By Mr. Thomson's plan, however great or small the trade might be at particular times on the canal, the whole engines must be kept in readiness and set agoing to move any number of vessels, however small, from one end of the canal to the other. By my plan, one locomotive engine boat only need be employed in each journey along the canal. In this way a very great expense will be saved.

2d. The moving power is always close to the body moved, and, in case of accidents, which would require a stoppage in the action of the impelling power, this stoppage can be instantly effected. To obtain this desirable object, under Mr. Thomson's system, the extremities of each stage or division of the road must be visible at the opposite extremity of that stage, so that a communication by flags or lights may be kept up between the stages. On this subject, describing his process, Mr. Thomson writes as follows:—" The two

"extremities being visible to each other, are furnished "with flags, to give alternate signals of the readiness of "the waggons to proceed. When the atmosphere is "hazy, and the flags cannot be seen, signals are made by "drawing forward the rope three or four yards, with the "engine at that end from which the waggons are intend-"ed to go, and which is instantly perceived at the other "end; and in the dark, (for the work is daily prosecuted "during five or six hours absence of light, at this period "of the year,) signals are given by a fire kept at each end "for lighting the workmen, which is shut from, or open-"ed to the view of the opposite extremity, by means of "a door. A person accompanies the waggons constantly, "seated in a chair fixed securely upon the fore-end of "one of the soles of the leading waggon of the set, "which is easily removed from one to another. The use "of such attendant is to disengage the hauling rope "from the waggons, by means of a spring catch, in the "event of any sudden emergency, such as the breaking "of a wheel or rail, or the hazard of running down any "object, the stage in common, lying over a common."

It is in comparison with Mr. Thomson's system, that the only doubt or uncertainty on the subject of my proposed plan occurs. This doubt or difficulty is as follows:—It has been ascertained, by experiment, that a

fixed engine acting through the medium of a rope on waggons, placed on a railway, can realize three-fourths of its nominal power, to be employed or used in accomplishing the end for which the engine was erected, viz. drawing the waggons from a distant point on the railway towards itself.

From this, it may of course be inferred, that a fixed steam engine, placed on the banks of a canal, would realize an equal power in drawing boats or vessels along the canal towards itself. It may, however, be doubted, and certainly it has not been ascertained by experiment, that a steam engine, built or placed in a boat, will realize the same quantity of power by its action on a rope, attached to a certain distant fixed point on a canal, which it would realize if placed on the bank of the canal. In answer to this difficulty, I have to state, that, among the advantages of my proposed plan, I have never brought into view the following great advantage which it possesses over Mr. Thomson's plan.

Mr. Thomson's engine has not only to exert a power sufficient to drag the waggons towards itself, but also a power sufficient to drag the rope; and the rope has not only to sustain the pull or force necessary to drag towards the engine the attached waggons, with the whole

weight of the two or three miles of rope, connecting the engine drum or cylinder with the distant carriages, but must sustain the friction occasioned by its being drawn along the railroad, the whole distance that the waggons are drawn. According to my plan, the engine never requires to exercise a greater force than is necessary to pull forward itself, with the attached boats; and the tracking rope never sustains a greater pull than this actual force or power, and is not moved or drawn along, but is merely coiled upon the drum or cylinder. We shall suppose a canal of an indefinite length, so formed as to admit of the application of a rope from one extremity of the canal to the other, so that there would be no stations for pillars or buoys. That a pull, equal to 1000 lbs., was necessary to drag forward a locomotive engine boat, with seven or eight boats attached to it, it is obvious, that although the rope, by means of which the locomotive engine boat moved forward with the attached boats, was not fastened or attached to the end of the canal opposite to that from which the locomotive engine boat proceeded, that the engine boat would proceed forwards as long as the quantity of rope remaining in the canal was of a weight sufficient to stand a pull of a thousand pounds. In such a case, according to Mr. Thomson's plan, his engine would require to be of a power, and his rope of a strength, sufficient not only to

give or sustain a pull or force equal to 1000 pounds, but also the pull or force necessary to drag the whole length of the rope, from the one end of the canal to the other. The freedom of my plan from such a disadvantage, should, I think, be more than a compensation for any loss of power consequent on the placing of the engine in a boat.

I shall now proceed to state the saving of expense which the adoption of my plan would secure for canal carriage.

I know that it is generally supposed that the expense of tracking boats along canals forms a very inconsiderable item of the charge for the carriage of goods and other articles. This supposition, however, is directly the reverse of the fact. For, after a careful enquiry, I have found that on large canals the expense of trackage does not amount to a sum less than from 40 to 50 per cent. of the toll dues or tonnages, and on small canals this expense must form 50, 60, or 70 per cent. of these toll dues or tonnages. On rivers, the charges of trackage, I should think, would be greater. In proof of this assertion I need only mention, that, on one canal, although the contract price paid by a certain set of traders, for the trackage of a masted vessel of fifty tons,

a distance of twenty-nine miles, with the disadvantage of a great number of locks, and a number of draw-bridges, is not above two-thirds of a farthing per ton per mile; yet the proportion which the total amount of the trackages paid by these traders, bears to the total amount of tonnages or toll duties, paid by them to the Canal Company, is very nearly as four to ten.*

On the canal abovementioned, the sum total of the annual expense for trackages, on the lowest calculation, amounts to nearly fifty per cent. of the tonnage or toll duties levied by the canal proprietors. This may be easily imagined, when we consider, that boats, light loaded, or empty, or in ballast, pay little or no toll duties, but must pay for trackage—that the low trackages abovementioned are a saving merely to *large companies*, and that double, triple, and even quadruple trackage is charged for vessels which navigate the canal only occasionally, or so irregularly that the masters cannot contract. The charges for trackage are, and must be the same, whatever the value of the goods carried may be. A ton of dung cannot be tracked cheaper than a ton of valuable goods.

* The traders abovementioned carry no coal or other low priced articles, and pay the expense of tracking ropes.

Low as the contract trackages abovementioned are, they are far higher than the prices at which the trackage could be afforded according to my plan; as will appear from the following statement.

We shall take, for example, a canal of ten miles in length.—To establish on it the conveyance of vessels by means of the Locomotive Engine Boat, the following would be the expense of the establishment:—

ORIGINAL COST.

1. Ten strong posts with hooks, iron work and mason work, at £10 each, . .	£100	0	0
2. Ten directing posts, per mile, to secure the rope in line and turn corners, at £1 each, ...	100	0	0
3. Two $3\frac{1}{2}$ inch ropes of ten miles, or 8800 fathoms length each, at ten pence per fathom, say	734	0	0
4. Three rough rafts or boats, whereof one is a spare one with steam engines of ten horse power, at £1000 each, .	3000	0	0
	£3934	0	0

ANNUAL CHARGES.

Interest on the above capital, at five per cent.	£196	0	0
Tear and wear on the whole, except the spare engine, at 30 per cent. say, .	436	0	0
Coals, engineman, and boy, grease, stores, &c. and two men for each working steam boat, at £300. per annum each,	600	0	0
The total expense would thus be,*	£1232	0	0

* I give, for the sake of comparison, Mr. Thomson's account for charges, &c. on a two mile stage of a level railroad, the engine a twelve horse one, estimated to cost £700. viz.

ESTIMATE.

	PER ANNUM.		
The ropes requisite for a two mile level stage, would be one of 3 inches, and one of 2½ inches, girt each the entire length of the plane—weight, 60 cwt.—would last 1½ year; *and deducting the value of the ropes when laid off, would amount to*	£90	10	0
An engineman 20s. and a boy 9s. per week, . .	75	8	0
A man to travel with the waggon 15s. and a boy to grease the friction wheels upon two stages, say a moiety at 9s. per week, ...	50	14	0
Stores, ...	9	9	0
Interest of capital, or 5 per cent. on the cost of the engine,	35	0	0
Carry forward,	£261	1	0

Each of these canal locomotive engine boats would realize a power (beyond the power necessary for dragging itself) equal to a pull of 900 lbs. and sufficient to drag six boats, each loaded with thirty-five or forty tons of coal, at the rate of two miles and a half, an

Brought forward,	£261	1	0
Wear and tear.—I allow a fixed engine to work 50 years, and in that period to incur a charge in repairs equal to one-half the first cost, deducting 10 per cent. on the cost sum, and dividing by the term of years, leaves the annual average charge—*i. e.* 700 + 350 — 70 ÷ 50 =	19	11	0
Grease and oil for the rope friction wheels and upholding them, ...	10	0	0
Small coals, 15 cwt. per day, which is nearly one-half above the calculation of Boulton and Watt, who allow one bushel to a 10 horse engine per hour, . .	0	1	6
Superintendance, I allow in this estimate, as in the former, ...	11	10	0
One co-operating engine is to be charged upon the whole series employed. In this case I shall suppose the system to consist of four stages, and the extra engine to stand at the beginning of the first stage, and to be used for the purpose only of drawing back the empty waggons—a 12 horse engine would enhance the charge in a very trifling degree; but I take a 6 horse engine as the power required, which could be erected for £500 with its machinery and house, &c. The charge upon it would be, interest £25, wear and tear £14, stoves (a moiety) £2 : 10s., engine man (18s. per week) £46 : 16s.—together, £88 : 6s.—divided by four stages,	22	1	6
Charge for one year, upon a two mile stage, on the reciprocating plan, ...	£324	5	0

hour, and to return with empty boats at the rate of four miles an hour. Allowing these locomotive engine boats to work fifteen hours a day, and to lose of this time an hour on each trip backwards and forwards from locks or otherwise, the two working canal locomotive engine boats would perform together four trips each day, conveying, at each trip, 225 tons of coals, or 900 tons of coals per day; and this supposing each boat only to carry 37 tons $\frac{50}{100}$ of coals. This amount multiplied by 300 working days, gives 270,000 tons of coals, moved ten miles, as the result of one year's work of the engines under my process; and that at a total expense of £1232 sterling, or about $\frac{10}{100}$ parts of a penny per ton per mile, *backward* and *forward*. I make this estimate on coal, as Messrs. Wood and Thomson's estimates are made on coal, without back-freight; of course a back freight would lower the charges nearly one-half. No allowance is made here for the increased rate of speed, as this increase is yet to be ascertained; but, I think, this increase may at least be rated at one-third, or a half, which would make a corresponding deduction on the rates above charged. The great advantage, however, will be the equalizing of the whole charge of trackage on the canal, so that every trader, however great his trade may be, or however small, will pay an equally low rate. The power of the